1.0 INTRODUCTION

This Draft Cleanup Action Plan (DCAP) sets cleanup standards and selects a cleanup action that meets those cleanup standards for the Lehigh Cement Company Closed Cement Kiln Dust (CKD) Pile Site (Site). The Site is located along State Route 31 west of Sullivan Creek in Metaline Falls, Washington. The cleanup action selected for the Site is based upon information contained in the Washington Department of Ecology's (Ecology) files, and information presented in remedial investigations (RIs) and the feasibility study (FS) completed by the Lehigh Cement Company (Lehigh). Lehigh has been named by Ecology as a potentially liable person (PLP) for the Site.

Ecology is responsible for the cleanup action selection and the completion of the DCAP. The selected cleanup action is intended to fulfill the requirements of the Model Toxics Control Act (MTCA) RCW 70.105D. More specifically, the objectives of this document are to satisfy the MTCA requirements set forth in WAC 173-340-380(1) and will include the following:

- A brief Site history description;
- A description of the nature and extent of Site contamination summarized from the remedial investigation (RI);
- Establishment of cleanup standards for each contaminated medium that are protective of human health and the environment;
- Presentation of proposed remedial alternatives summarized from the feasibility study (FS); and
- Ecology's selected cleanup action.

1.1 Site Location

The Site, defined as where hazardous substances have come to be located, includes the Closed CKD Pile and a groundwater contaminant plume. As shown in Figure 1, the Site is located east of Quarry Road and west of Sullivan Creek and is bisected by State Route 31 in Metaline Falls, Washington. The Closed CKD Pile is bounded to the north by a timbered hillside and a small drainageway known as the North Rill and a larger, steeper hill slope to the south and another small drainageway, called the South Rill. The Closed CKD Pile encompasses approximately 7.5 acres and contains about 544,000 tons of CKD. The groundwater plume extends from under the Closed CKD Pile toward Sullivan Creek to the east, and is generally located between Monitoring Well MW-8 to the south and Monitoring Well PM-19 to the north.

Metaline Falls is located in northeast Washington approximately 13 miles south of the Canadian border and 15 miles west of the Idaho border. The Site is located in southeast quarter of Section 21, Township 39 North, Range 43 East, Willamette Meridian (WM) in Pend Oreille County, Washington.

1.2 Applicability

This DCAP is applicable only to the Lehigh Cement Company Closed CKD Pile Site in Metaline Falls, Washington. The remedial actions to be taken at this Site were developed to meet the threshold requirements and other requirements of WAC 173-340-360. Cleanup standards have been developed and cleanup actions selected as an overall remediation process being conducted under Ecology oversight using MTCA authority. Ecology's decisions regarding these matters should not be considered as setting precedent for other sites.

1.3 Administrative Documentation

Documents used to develop this DCAP and the decisions contained herein are contained in Ecology's files. The administrative record for this Site is on file and available for public review by appointment at Ecology's Eastern Regional Office, located at 4601 N. Monroe, Spokane, Washington 99205-1295. Documents that were made available for public comment are also available at the Metaline Falls Public Library (in the Cutter Theater Building). The following documents were used to develop the proposed cleanup action:

- **Cemtech, Inc., 1990. Kiln Dust Management Facility Closure Plan.** August 1990
- **Dames & Moore, 1992. Preliminary Site Characterization Report, Lehigh Portland Cement Company, Metaline Falls, Washington.** December 1992.
- **Dames & Moore, 1993. Addendum Preliminary Site Characterization Report, Lehigh Portland Cement Company, Metaline Falls, Washington.** December 1992.
- **Dames & Moore, 1995. Final Closure Plan for the Closure of the Cement Kiln Dust (CKD) Pile, Lehigh Portland Cement Company, Metaline Falls, Washington.** July 1995.
- **Dames & Moore, 1997. Closure Report for the Cement Kiln Dust (CKD) Pile, Lehigh Portland Cement Company, Metaline Falls, Washington.** June 1997.
- **GeoSyntec Consultants, 1998. Construction Documents for the Washington Department of Transportation Interim Deck Extension, Cement Kiln Dust Pile Closure, Lehigh Portland Cement Company, Metaline Falls, Washington**. October 1998.
- **GeoSyntec Consultants, 2000. Interim Progress Report No. 1, Subsurface Treatability Study, Lehigh Portland Cement Company, Metaline Falls, Washington**. September 2000.
- **GeoSyntec Consultants, 2001. Draft Final Remedial Investigation Report, Lehigh Portland Cement Company, Metaline Falls, Washington**. October 2001.
- **GeoSyntec Consultants, 2002. Design Drawings for the Pilot In-Situ Carbon Dioxide Groundwater Treatment System, Closed Cement Kiln Dust Pile, Lehigh Portland Cement Company, Metaline Falls, Washington**.

- **GeoSyntec Consultants, 2003a. Construction Report, Pilot Groundwater Treatment System, Lehigh Portland Cement Company, Metaline Falls, Washington**. April 2003
- **GeoSyntec Consultants, 2003b. Feasibility Technical Memorandum, Closed Cement Kiln Dust Pile, Lehigh Portland Cement Company, Metaline Falls, Washington**. May 2003.
- **GeoSyntec Consultants, 2004. Supplement to the Draft Feasibility Study Technical Report and Technical Response to the Department of Ecology Request for Further Field Investigation, Closed Cement Kiln Dust Pile, Lehigh Portland Cement Company, Metaline Falls, Washington**. May 2004.
- **GeoSyntec Consultants, 2005. Revised Draft Feasibility Study Technical Report, Closed Cement Kiln Dust Pile, Lehigh Portland Cement Company, Metaline Falls, Washington**. March 2005.
- **Washington Department of Ecology, 2001. Model Toxics Control Act, Chapter 173-340 WAC.** Publication No. 94-06.
- **Washington Department of Ecology, 2001. Cleanup Levels and Risk Calculations under the Model Toxics Control Act, Version 3.1.** Publication No. 94-145.

1.4 Cleanup Process

Cleanup conducted under the MTCA process requires specific documents to be completed and submitted to Ecology. The DCAP and Public Participation Plan are documents completed by Ecology. These documents are used by Ecology to obtain more detailed information and determine the remedial actions to be conducted and the monitoring requirements prior to and following a cleanup action. These procedural tasks and resulting documents, along with the MTCA section that requires their completion, are listed below with a brief description of each task.

- Remedial Investigation and Feasibility Study - WAC 173-340-350
- Draft Cleanup Action Plan - WAC 173-340-380
- Engineering Design Report - WAC 173-340-400
- Construction Plans and Specifications - WAC 173-340-400
- Operation and Maintenance Plan(s) - WAC 173-340-400
- Cleanup Action Report - WAC 173-340-400
- Compliance Monitoring Plan - WAC 173-340-410
- Public Participation Plan - WAC 173-340-600

The Remedial Investigation and Feasibility Study (RI/FS) process documents the investigations and engineering evaluations conducted at the Site from the discovery phase to the final RI/FS. The investigations are designed to characterize the type and extent of contamination and the associated risks posed by the contamination to human health and the environment. The FS presents and evaluates different Site cleanup alternatives and proposes the preferred cleanup alternative. The Draft Remedial Investigation Report and Revised Draft Feasibility Study Technical Report (DFSTR) were reviewed by Ecology, made available for public review and comment, and then finalized.

The DCAP sets the cleanup standards for the Site and selects the cleanup actions intended to achieve the cleanup standards. After opportunity for public comment and any revisions made following public comment, the DCAP is finalized with an attached responsiveness summary and becomes the cleanup action plan (CAP).

The Engineering Design Report outlines the engineered system and design components of the CAP. Construction Plans and Specifications provide the technical drawings and specifications for design and implementation of the CAP.

The Operation and Maintenance (O&M) Plan(s) summarizes the requirements for inspection and maintenance as well as the regulatory and technical necessities to assure effective operations. The O&M Plan(s) outline the actions required to operate and maintain any equipment, structures, or other remedial facilities used in the cleanup action.

A Cleanup Action Report will be completed following implementation of the selected cleanup action. The report will detail the activities performed for the Site cleanup action and provide documentation of adherence to or variance from the CAP.

Compliance Monitoring Plans are designed to serve the following three purposes:

- Protection – Confirm that human health and the environment are being protected during construction and O&M tasks for the cleanup action at the Site.
- Performance – Confirm that the cleanup action has attained cleanup standards.
- Confirmational – Confirm the long-term effectiveness of the cleanup action after cleanup standards have been attained.

The Public Participation Plan is the framework to provide the public with information and give it the opportunity for participation in a site. This plan is tailored to the meet the public's needs and coordinate its effort in the MTCA process.

2.0 SITE HISTORY

The following paragraphs provide a brief summary of ownership, operational, and regulatory history of the Site. The information provided herein was provided in the Remedial Investigation reports completed by Dames & Moore, Inc., GeoSyntec Consultants, and other reports provided to Ecology.

The information contained herein is not the result of a title search and is based upon information gathered from various sources. From 1914 to 1989, Lehigh operated a cement plant in Metaline Falls, Washington. The plant utilized a dry processing kiln as part of the production process. The resulting kiln gases were routed through the plant's dust collection systems. Cement kiln dust (CKD), a by-product of Portland cement production, was produced and collected from the Lehigh plant. The CKD was transported from the dust collection systems to a ravine across Quarry Road, east of the plant. Approximately 544,000 tons of CKD were placed in the ravine to form the CKD landfill. Lehigh sold the cement production plant and specific land holdings to Lafarge Corporation in 1989. Lehigh retained ownership of the CKD landfill. Lehigh capped the CKD Pile and installed other closure systems in 1996, in accordance with an Ecology-approved Closure Plan. During closure discussions in 1994, both Ecology and Lehigh began to refer to the CKD landfill as the CKD Pile. In 1996, the closed landfill then became known as the Closed CKD Pile.

Downgradient groundwater impacts persisted following closure of the CKD Pile. Since closure of the CKD Pile, Lehigh has conducted several groundwater investigations, and installed a pilot-scale in situ treatment system. The FSTR, which evaluated a variety of treatment technologies to address the groundwater contamination, recommended a preferred cleanup action for the Site. This DCAP describes the planned implementation of the cleanup action.

2.1 Regulatory History

The following is a brief regulatory history of the Site.

- In 1981, Ecology inspected the CKD landfill and determined that the CKD landfill was subject to the Water Pollution Control Act (RCW 90.48) and the Solid Waste Management Act (RCW 70.95).
- Lehigh submitted Dangerous Waste Permit Forms 1 and 3 and a Part A application to Ecology in 1984 in order to fulfill WAC 173-303 requirements.
- In 1984, Lehigh also submitted a petition to Ecology to exempt the CKD from the Dangerous Waste Regulations.
- Ecology issued a tentative denial of the petition to exempt CKD from the Dangerous Waste Regulations in 1985.
- On February 1, 1990, Ecology sent a letter to Lehigh informing Lehigh that the CKD landfill was out of compliance with Dangerous Waste Regulations for interim status facility standards. At that time, Ecology provided two options for compliance with the regulation.
- In March 1990, Ecology issued a final denial of petition for exemption of the CKD from the Dangerous Waste Regulations.
- Lehigh submitted a closure plan to Ecology in August 1990.
- In 1992, Lehigh received approval for a site characterization work plan. The site characterization was completed from August 1992 to February 1994.
- Ecology requested that Lehigh submit a Draft Closure Plan for the CKD Pile in 1994.
- In 1994, a Draft Closure Plan was submitted to Ecology.
- In 1995, Lehigh submitted a Post-Closure Care and Maintenance Plan to Ecology.
- A final Closure Plan and Design Report were submitted to Ecology in 1996.
- The approved closure plan was implemented in 1996.
- In 1996, Ecology issued Administrative Order No. DE96HS-E934 to Lehigh for

the submittal and implementation of a short-term post-closure care plan that included two years of groundwater monitoring.

- In 1997, Lehigh submitted a "Short-Term Post-Closure Care Plan" and a "Closure Report for the Cement Kiln Dust (CKD) Pile" to Ecology.
- An Emergency Order No. DE98-HS-E938 was issued under MTCA authority to Lehigh in order to complete a Washington Department of Transportation (WSDOT) Deck Extension in 1998. The deck extension reduced the potential for direct contact with high alkaline groundwater that surfaced and ponded on the property.
- In April 1999, Lehigh submitted the "Post-Closure Care Groundwater Data Review" that described the two years of groundwater data that were collected following closure.
- In December 1999. Ecology and Lehigh entered into an Agreed Order No. DE99HS-E941 for the completion of a RI/FS for the contaminated groundwater downgradient of the Closed CKD Pile.
- Amendment to Agreed Order No. DE99HS-E941 to accommodate a pilot test and treatability study was signed in 2001.
- Lehigh submitted a RI report to Ecology in 2001.
- A pilot groundwater treatment system was installed in October and November 2002, and the construction report was submitted in 2003.
- A Feasibility Study Technical Memorandum was submitted in May 2003.
- Additional summer investigation and performance monitoring was completed in the summer of 2003.
- The first draft of a Feasibility Study Technical Report was submitted in November 2003.
- Ecology completed a summer investigation in 2004 to assist in conceptual site model analysis.
- The final draft of the Feasibility Study Technical Report was submitted in March 2005 and was made available for public comment in May 2005 and finalized in June 2005.

3.0 PHYSICAL SETTING

The Site is located immediately southeast of Metaline Falls, Washington in the southeast quarter of Section 21, Township 39 North, Range 43 East, Willamette Meridian (WM). Topographic map coverage of the Site and vicinity is provided by the Metaline Falls Quadrangle, U.S. Geological Survey, 7.5 minute series dated 1967 and photorevised in 1986. The Closed CKD Pile's elevation along Quarry Road is about 2110 feet above sea level and approximately 2025 feet near State Route 31 using the National Geodetic Vertical Datum (NGVD) of 1929. The elevation of the portion of the Site between State Route 31 and Sullivan Creek is approximately between 2020 and 2025 feet above sea level.

Sullivan Creek is the nearest surface water body and forms the eastern boundary of the Site. Sullivan Creek joins the Pend Oreille River downstream from the Site. The Pend Oreille River is the major surface water course in the area and is located approximately

1,700 feet west of the Site. In the Site vicinity, the Pend Oreille River flows north into Canada.

3.1 Regional Geology

The Site lies within the Metaline Lead-Zinc District, which encompasses about 75 square miles (Dings and Whitebread 1965). The Metaline District is characterized by sediments deposited in a carbonate reef environment. The oldest rocks were deposited during the Cambrian Period. The deposition in the shallow marine environment continued through the Ordovician Period into the Silurian/Devonian Period. This deposition resulted in sequences of limestone, dolomite, and shale. Toward the end of the marine deposition, depositional evidence such as the Ledbetter Slate suggests a transition from a shallow environment to deep marine sedimentation. A large quantity of breccias observed within the carbonate rocks as well as turbidite beds within the Ledbetter Slate suggests a tectonically active basin margin that was rapidly deepening (Morton 1992).

As a result of the major orogenic or mountain building episode during the Cretaceous Period, the Metaline area rocks were folded, faulted, and intruded by igneous dikes, stocks, and sills. During the Tertiary Period, folding and faulting occurred within the Metaline District, which resulted in the formation of the graben that characterizes the Metaline District. Several northeast trending low-angle thrust faults indicate compression of the sedimentary carbonates either prior to or during graben formation.

During the Quaternary Period, continental glacial ice began to shape the landscape. Glaciofluvial and glaciolacustrine sediments covered the Metaline area. Erosion has shaped the current landscape of incised highlands and glacial valleys. Glacial lake bed sediments are the most dominant glacial sediment in the Metaline area and range in thickness from 200 to 500 feet (Dings and Whitebread 1965).

3.1.1 <u>Site Geology/Waste Pile Configuration</u>

Borings and monitoring wells were installed through the CKD landfill prior to its closure. Based on the borings, CKD thicknesses vary from 72 feet at monitoring well MW-1 at the northern end to 39 feet in monitoring well MW-6 at the southern end (Figure 2). The CKD appears thickest in the area of boring B-3 near the center, where the CKD was 78 feet thick. The thickest sequence of native soil under the CKD landfill, 28 feet, was encountered in the MW-1 boring. The native soil consists of sandy silt to silty sand and sandy gravel. Based on the soil borings, the soil underlying the north and south edges is mostly sandy silt and grades to more granular material such as gravelly sand near the pile center.

The soil underlying the former WSDOT property east of State Route 31 consists of interlayered sandy silt to silty sand with trace or more amounts of clay. The fine-grained soil is underlain by silty to sandy gravel. The gravel varies from five to ten feet in thickness in this area. The saturated gravel overlies a silty clay to clay unit. The clay unit appears to be a low permeability unsaturated unit. Borings or monitoring wells have not been completed through this clay unit to determine the thickness. In Boring FSB-04 between State Route 31 and Sullivan Creek, 13 feet of the clay unit was encountered prior to abandonment of the boring.

3.2 Regional Hydrogeology

Groundwater occurs in the alluvial and unconsolidated glacial sediments as well as the underlying bedrock. In the Metaline Falls area, the unconfined alluvial aquifer is underlain by the laterally continuous Ledbetter Slate, which separates the alluvial aquifer from the deeper bedrock aquifer located within the Metaline Limestone. The unconsolidated glacial and alluvial deposits provide the majority of the domestic production in the area. The thickness of the glaciofluvial and glaciolacustrine sediments is dependent on the bedrock topography and is generally thickest near major streams and thins away from the valleys. Based on review of well logs on file with Ecology, domestic and commercial wells in the Metaline Falls area that are completed in bedrock have been found to yield between 30 to 250 gallons per minute.

3.2.1 Site Hydrogeology

The aquifer that flows beneath the Site is an unconfined water bearing zone that occurs within sandy silt to silty sand and sandy gravel. The initial assessment of hydrogeologic conditions consisted of the installation of eight piezometers. Seven of the piezometers were installed through the CKD and one was installed at the southern toe of the landfill. Prior to closure, eleven monitoring wells were installed at the Site to monitor groundwater. Monitoring well MW-11, located southwest of the landfill along Quarry Road, served as the upgradient well, while monitoring well MW-4, located west of the landfill along Quarry Road, was considered cross-gradient. Two monitoring wells, MW-1 and MW-6, were completed through the CKD in order to monitor conditions beneath the landfill. Four monitoring wells were placed between State Route 31 and the CKD landfill and three additional wells were placed east of State Route 31. These seven wells were considered downgradient of the landfill.

Since closure in 1996, a total of twenty-five (25) monitoring wells and sixty-one (61) temporary wells have been completed at the Site. The total of sixty-one (61) temporary wells includes ten temporary wells that Ecology installed during its 2004 summer investigation. With the exception of twenty temporary wells, the permanent and temporary wells were completed east of State Route 31, downgradient of the Closed CKD Pile.

The groundwater flow direction downgradient of the Closed CKD Pile is generally northeast. The flow direction can vary slightly based on seasonal flow characteristics. A horizontal hydraulic gradient of 0.097 feet/foot was estimated underneath the Closed CKD Pile from data collected from monitoring wells MW-6 and MW-3. The gradient flattens as it crosses State Route 31 and encounters the Sullivan Creek flood plain. A horizontal hydraulic gradient of 0.040 feet/foot was estimated east of State Route 31 and is based on data from monitoring wells MW-8 and MW-12.

Groundwater discharges to Sullivan Creek in the Site area. During times of shallow surface water flow, amber colored groundwater seep discharge can be observed along the bank. The groundwater discharge quality will be discussed in Section 4.0.

3.3 Surface Water

Sullivan Creek forms the eastern boundary of the Site. The creek flows west along the site and turns north near the northeast corner of the Site and continues for about 700 feet. Following this northerly run, Sullivan Creek turns and flows west again to its confluence with the Pend Oreille River. At its closest point, the Pend Oreille River is located approximately 1,600 feet northwest of the Site.

The Pend Oreille River, one of the major sub-basins of the Columbia River, drains headwater basins in Montana and Idaho and flows through the northeast corner of Washington. The Pend Oreille River joins the Columbia River in southern British Columbia. The Pend Oreille River watershed is comprised of nineteen sub-basins and drains an area of about 25,200 square miles. The Site is located within the Sullivan sub-basin, the largest sub-basin in the watershed, draining 142 square miles.

The headwaters of Sullivan Creek begin as an outlet for Sullivan Lake and flows are regulated by Sullivan Dam. The Washington Department of Fish and Wildlife has established a minimum flow for Sullivan Creek below Mill Pond Dam. The minimum flows are set for the months of October through March at 75 cubic feet per second (cfs). These minimum flows are critical for fish egg incubation.

4.0 REMEDIAL INVESTIGATION

In 1992, Lehigh began preliminary characterization of the CKD landfill for the purpose of assessing closure options. The characterization included completion of the following:

- Installation of eleven soil borings, six of which were completed as monitoring wells.
- Collection of background soil samples as well as surface CKD samples for chemical analysis.
- Identification of three groundwater seeps and sample collection for chemical analysis.
- Identification of three surface water sampling stations in Sullivan Creek for stream flow and sample collection for chemical analysis.
- Collection of eight sediment samples in seep and surface water locations.

The preliminary characterization indicated that groundwater downgradient of the CKD landfill was affected by high pH and select metals. The chemical characterization of the CKD indicated that a subset of the CKD samples contained elevated concentrations of cadmium, chromium, and lead. Toxicity characteristic leaching procedure (TCLP) analysis indicated that the CKD did not exceed dangerous waste regulations for the elevated metals. However, some of the CKD samples had a pH greater than 12.5

standard units (SU), and therefore, the material qualified as a state-only dangerous waste under WAC 173-303-090(6).

Additional site characterization was performed in 1993 in order to further characterize downgradient groundwater impacts and provide geotechnical information to develop engineering design considerations for the closure plan. The 1993 field program included:

- Installation of three soil borings into the CKD for geotechnical engineering analysis.
- Installation of five additional monitoring wells.
- Collection of groundwater samples from existing wells and the new wells.
- Collection of two groundwater seep samples downgradient of the CKD landfill.

The groundwater information collected from this field program supports conclusions made from the first characterization program. Three of the five new wells installed indicated that CKD had not impacted the wells. The seep sample collected east of State Route 31 contained elevated pH and metals similar to the affected groundwater in monitoring wells.

Following the completion of the second phase of characterization, work began on drafting a closure plan for the CKD landfill. A draft closure plan was submitted to Ecology in 1994. Lehigh submitted a Post-Closure Care and Maintenance Plan to Ecology in 1995. The final closure plan was approved by Ecology in 1996 and was implemented in 1996. The closure plan included placing a cover system on the pile to reduce water infiltration, installing a stormwater management system, and performing post-closure care of the cover and water control systems.

Agreed Order DE96HS-E934 provided for the short-term post-closure care of the Closed CKD Pile and two years of groundwater monitoring. The groundwater monitoring indicated that the contaminated groundwater observed prior to closure continued to be present downgradient of the Closed CKD Pile. In addition to the groundwater monitoring, an emergency action was completed in 1998. The project, known as the Washington Department of Transportation (WSDOT) Deck Extension, entailed filling a topographic low area on WSDOT property east of State Route 31. This low area represented an immediate threat to human health and the environment due to the surfacing and accumulation of highly alkaline groundwater.

An Agreed Order was signed in 1999 for the completion of a focused Remedial Investigation/ Feasibility Study (RI/FS) of groundwater and surface water contamination associated with the Closed CKD Pile. The RI/FS Work Plan was finalized in October 1999. The focused RI program was developed to further characterize and define the groundwater contamination. The focused RI program was conducted by Lehigh's consultant, GeoSyntec, with a final report submitted to Ecology in 2001. The focused RI program included:

- Re-drilling two monitoring wells and installing one new monitoring well.
- Drilling twenty temporary wells east of State Route 31.

- Sampling permanent and temporary wells to monitor groundwater quality.
- Sampling surface water from seeps.
- Sampling soil from downgradient of the Closed CKD Pile.
- Surveying monitoring well elevations.

The RI work is documented in the report titled: Final Report Remedial Investigation Closed Cement Kiln Dust Pile, Metaline Falls, Washington. October 2001. The RI Report presents a summation of previous investigations conducted at the Site and the findings of the focused RI program.

Soil and CKD samples were collected during the earlier characterization phases of the project in 1992 and 1993. Additional soil samples were collected in 1999 during the RI. CKD samples and native soil samples were analyzed for total metals. The results suggested that the CKD and soil metal concentrations were similar. These concentrations were mostly below MTCA Method A cleanup levels.

Sediment samples collected in 1992 from Sullivan Creek indicated that total metal concentrations were below MTCA Method A soil cleanup levels. Sediment samples collected in 1998 from the ponded water area on the WSDOT property that was subsequently covered in the deck extension project also showed that total metal concentrations were below MTCA Method A soil cleanup levels.

Groundwater samples were collected prior to placement of the cover system, with collection continuing after cover placement. Groundwater samples collected during the characterization phase of the project prior to CKD Pile closure were submitted for volatile organic and semi-volatile organic compounds. Sample results were either below detection limits or well below Method B cleanup levels. Method B levels were used for comparative purposes. Samples were also submitted for total metals analysis of aluminum, antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc; total petroleum hydrocarbon identification; and alkalinity. Some of the samples contained elevated concentrations of arsenic, cadmium, chromium, and/or lead.

Following cover system placement, the groundwater sample parameters focused on pH, metals and analytes specific to geochemical analysis such as major cations and anions. Sample analyses indicated that high pH continued to be present downgradient of the Closed CKD Pile. In addition to the elevated pH, arsenic concentrations were observed to be above Method A cleanup levels in samples from downgradient wells. Lead and chromium concentrations have decreased since the CKD Pile was closed.

Surface water samples were collected from seeps discharging to Sullivan Creek and from locations near the Closed CKD Pile. The samples were submitted for total metals analysis of aluminum, antimony, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc and alkalinity. Seep water analysis indicated that high pH and elevated arsenic concentrations were present in the seep samples from downgradient of the Closed CKD Pile.

4.1 Groundwater Contamination

Groundwater beneath and along the margins of the Closed CKD Pile comes in contact with the CKD. This results in highly alkaline water with a pH that has been measured as high as 13.9 standard units (S.U.). The high pH groundwater strips native metals from the surrounding soil and transports the dissolved metals downgradient of the Closed CKD Pile. For the first level of screening, a Method A cleanup level for contaminants was used. Of the elevated metals in groundwater downgradient of the Closed CKD Pile, arsenic is the only metal that continuously exceeds a MTCA cleanup level. Chromium and lead were encountered in the early phases of investigation, and while concentrations are still elevated, levels have decreased. The Method A groundwater cleanup level for arsenic is 5 parts per billion (ppb), which is based on natural background for the state of Washington.

As discussed, groundwater pH measurements at the Site range as high as 13.9 S.U. The high pH groundwater flows from the Closed CKD Pile beneath State Route 31 and encounters the flood plain of Sullivan Creek. The plume moves north to mostly northeast on the east side of the highway.

4.2 Pilot Treatment Wall

Following completion of the RI, Lehigh proposed to test, at the pilot scale, an innovative technology for contaminated groundwater treatment. The technology involved lowering pH in-situ by diffusing carbon dioxide gas into the groundwater via a subsurface treatment wall. The carbon dioxide reacts with groundwater to form the weak dissociable acid, carbonic acid, and in turn lowers the pH. The pilot treatment wall was installed to assess the delivery and treatment capability of in-situ carbon dioxide diffusion. The wall was operational in November 2002 and has been operated since then. The pilot treatment wall has demonstrated the ability to lower groundwater pH to within the cleanup level range of 6.5 to 8.5.

4.3 Summer Investigation

In July 2004, Ecology completed a field investigation to assess the presence of seeps in the south rill area and groundwater in the Closed CKD Pile toe area. Seven soil borings were completed at the Closed CKD Pile toe and three soil borings in the south rill area. Temporary well screens were placed in six of the borings in the toe area. The temporary wells were used to measure groundwater elevations and measure the pH at each location.

Three borings completed in the south rill area were used to assess the presence of seeps. Soil samples were retrieved from the borings and submitted to the laboratory for physical testing, which included moisture density and moisture content. Based on the investigation results in the south rill, Ecology does not believe the “seeps” area as described in the Draft Feasibility Study Technical Report is a significant source of groundwater.

5.0 CLEANUP STANDARDS

The cleanup standard development process is used to determine which hazardous substances contribute to an overall threat to human health and the environment at a site. Once these substances are identified, an evaluation is made to determine at what concentration these substances are considered to be protective of human health and the environment. A point of compliance is then established on the Site, which is a point or points where these cleanup levels must be attained (WAC 173-340-200). Cleanup standards include both cleanup levels and points of compliance for those cleanup levels.

MTCA provides three main methods for establishing cleanup levels at a site. These are Method A, B, and C. Method A provides cleanup levels for routine cleanup actions or sites with relatively few hazardous substances. Methods B and C cleanup concentrations are calculated from applicable or relevant and appropriate requirements (ARARs) and from using the formulas provided in WAC 173-340-720 through WAC 173-340-760. Method B is the standard method for establishing cleanup levels and is applicable to all sites. Method C is a conditional method for use at sites subject to specified uses.

Following establishment of cleanup levels, media having concentrations above cleanup levels must be addressed using one or more technologies selected as part of the remedy. Criteria for remedy selection are outlined in WAC 173-340-360.

Groundwater is the contaminated medium at the Site. Arsenic, lead, chromium, manganese, and high pH are the indicator substances (as defined in Section 5.1 below) that have been identified in this medium. The metal contamination is a direct result of the high pH, since the high pH groundwater strips and transports native metals from the surrounding soil.

Two exposure pathways have been considered in establishing cleanup standards for this Site. These pathways are the protection of groundwater and surface water. Even though the Site is located in an area that allows for a mixture of uses, Ecology has determined that the most reasonable exposure scenario is contact via ingestion of contaminated drinking water and dermal contact with groundwater and surface water.

Groundwater cleanup standards are set according to WAC 173-340-720. As stated previously, the highest beneficial use of Site groundwater is as a current and future drinking water source. Ecology has determined that the reasonable maximum exposure expected is through ingestion of drinking water and other domestic uses (WAC 173-340-720 (1) (a)). A Method B cleanup standard will be used for establishing cleanup levels in groundwater at the Site.

5.1 Indicator Substances

Indicator substances as defined by WAC 173-340-200 are a subset of hazardous substances present at a site selected under WAC 173-340-708 for monitoring and analysis during any phase of remedial action for the purpose of characterizing a site or establishing cleanup requirements for a site.

As discussed above, metals and pH have been identified as chemicals of concern at the Site. Indicator substances are selected from the list of chemicals of concern. The criteria found in WAC 173-340-703 are used to screen the list of chemicals. Following the selection of indicator substances, cleanup levels are developed for the list of substances that are used to calculate the total site risk. Protection of groundwater is considered in conjunction with exposure scenarios. For non-carcinogenic substances, the summation of risk for each toxic endpoint of all media must not exceed a hazard index of one. For establishing cleanup levels of carcinogenic substances, the total cancer risk from all chemicals in the affected media must not be greater than one in one hundred thousand or $1x10^{-5}$.

5.1.1 Groundwater Indicator Substances

As discussed previously, the highest beneficial use of Site groundwater is as a current and future drinking water source. Exposure through ingestion and other domestic uses is the main groundwater pathway. Arsenic, chromium, lead, manganese, and pH will be used as indicator substances for groundwater. Groundwater indicator substance screening results are presented as Table 1.

Metals contamination at this Site is associated with elevated pH concentrations. The arsenic concentrations appear to diminish along the plume edges more rapidly than the decreases in groundwater pH. The metals contamination plume lies within the pH plume.

5.2 Cleanup Standard Development

The indicator substance screening yielded five groundwater contaminants that will be carried forward for cleanup standard development. While soil cleanup levels will not be developed for the Site, soil downgradient of groundwater treatment system may accumulate arsenic, lead, chromium, or manganese. In the event soil within the treatment system corridor requires removal to improve flow and treatment conditions, the soil will be subject to analytical testing in order to determine proper disposal requirements. Groundwater cleanup levels will be set to be protective of human health via ingestion and other domestic uses as well as protection of surface water.

5.2.1 Groundwater Cleanup Levels

Groundwater levels set under Method B for groundwater must be at least as stringent as the criteria in WAC 173-340-720(4)(b), which includes the following:

i) Concentrations established under applicable state and federal laws, including the requirements in WAC 173-340-720(3)(b)(ii), which includes the following:

ii) For protection of surface water beneficial uses.

iii) For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal laws, those concentrations which protect human health as determined by the equations presented in WAC 173-340-720 (3)(iii)(A) and (B).

To develop cleanup levels for the Site, Ecology evaluated existing Site groundwater data and compared these data to Method B cleanup levels. Table 2 presents the Method B cleanup levels for indicator substances arsenic, lead, chromium, manganese, and high pH in groundwater. Groundwater at the Site discharges to Sullivan Creek, resulting in groundwater cleanup levels that must be set to be protective of drinking water and surface water.

For arsenic, the most stringent of these concentrations is the National Toxics Rule (NTR) 40 CFR 131 surface water concentration of 0.018 micrograms per liter (ug/L). However, this concentration is less than the natural background concentration of arsenic for the state of Washington. When a cleanup level is less than a natural background level, the cleanup level is established at a concentration equal to the natural background concentration, WAC 173-340-700(6)(d). Therefore, the groundwater cleanup level for arsenic for protection of surface water and drinking water will be 5 ug/L.

Chromium has a cleanup level of 10 ug/L, which is based on the National Toxics Rule (NTR) 40 CFR 131 and WAC 173-201A for a chronic exposure to aquatic life. This chromium concentration is based on the assumption that hexavalent chromium is present in the total chromium results. WAC 173-201A also establishes the water quality criterion for lead at 1.85 ug/L. Similar to arsenic, this concentration is less than the natural background concentration for lead in the state of Washington. The cleanup level for lead will be set at the established background concentration of 5 ug/L. The manganese cleanup level will be established using the Method B cleanup level for non-carcinogenic contaminants, which sets the manganese concentration at 2,240 ug/l for protection of human health.

The pH cleanup level for the Site is based by reference on the water quality criteria set forth under WAC 173-201A. The surface water criteria establish a cleanup level range of 6.5 to 8.5 standard units. The pH cleanup level is set for protection of drinking water and surface water.

A point of compliance (WAC 173-340-200) is the point or points where cleanup levels established in accordance with WAC 173-340-720 through 173-340-760 shall be attained. Once those cleanup levels have been attained at that point, a site is no longer considered a threat to human health and the environment. If a conditional point of compliance is established (see below), institutional controls must remain in place to prevent exposure where hazardous substances remain on-site above cleanup levels.

Under MTCA, the standard groundwater point of compliance is throughout a site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the Site (WAC 173-340-720(8)(b)).

Where hazardous substances remain on-site as part of the cleanup action, a groundwater conditional point of compliance, which shall be as close as practicable to the source of hazardous substances not to exceed the property boundary, may be used. If a conditional point of compliance is used, the proponent shall demonstrate that all practicable methods of treatment are utilized in the cleanup action (WAC 173-340-720(8)(c)). A conditional point of compliance has been selected for use at the Site, as explained in Section 7.1 below. Groundwater outside of the subsurface hydraulic barrier will be subject to this conditional point of compliance.

The remedy selected for the Site includes groundwater treatment, as explained in Section 7.0. Groundwater will pass through an engineered subsurface treatment system where it will be treated and then discharged through an engineered effluent outfall to Sullivan Creek. When it passes through this system, it loses its character as groundwater. The treated water will therefore have to meet surface water cleanup levels instead of groundwater cleanup levels. Since groundwater cleanup levels were developed to be protective of surface water at this Site, they will also be used as surface water cleanup levels. In addition, as also described in Section 7.1, groundwater that has undergone treatment and is discharged to surface water through an effluent outfall will be subject to a point of compliance for surface water cleanup levels pursuant to WAC 173-340-730(6)(a).

5.3 Overall Site Risk

Arsenic is considered the only carcinogenic substance at the Site. Since the cleanup level is set at background, a cancer risk was not calculated for the Site. The hazard index for the Site is one. This is derived from a combination of risk associated with the five indicator metals and pH in groundwater. The hazard quotient calculations are presented as Table 3. The effects from non-carcinogenic substances were used to determine the hazard index by summation of the hazard quotients. The highest calculated hazard index is 1 for manganese due to neurotoxicity.

6.0 REMEDIAL ALTERNATIVES

The FS identified six alternatives for groundwater remediation and each alternative involves groundwater treatment. In addition to groundwater treatment, two alternatives involve source control while a third alternative involves partial source removal. The alternatives are as follows:

- Permeable Treatment Wall
- Groundwater Control
- Additional Source Control
- Partial Source Removal
- Funnel and Gate Treatment
- Partial Additional Source Control

The alternatives were developed to comply with MTCA including other applicable or relevant and appropriate requirements (ARARs), and to provide protection of human health and the environment. The six cleanup alternatives involve groundwater treatment.

6.1 Alternative 1 – Permeable Treatment Wall

Alternative 1, the Permeable Treatment Wall, utilizes the same technology tested in the Pilot Groundwater Treatment System and extends the treatment wall to the north along the east side of State Route 31 (Figure 3). The preliminary design includes treatment wall sections that would be linked with barrier wall panels. The barrier panels would direct CKD affected groundwater to the treatment zones. The treatment zones would contain perforated plastic pipes encasing silicone tubing. The tubing would be used to diffuse carbon dioxide into groundwater, resulting in carbonic acid production. The carbonic acid would neutralize the high pH water, which in turn would reduce the soluble arsenic concentrations in groundwater. The complexes formed by the pH adjustment would precipitate in the soil matrix. Based on computer modeling, the precipitates will remain stable. In order to address the possibility that CKD affected groundwater may bypass the treatment zone, a limited number of extraction wells would be installed to extract the errant groundwater and route it back to the treatment zone.

6.2 Alternative 2 – Groundwater Control

Groundwater Control, Alternative 2, combines groundwater extraction wells with the existing pilot Permeable Treatment Wall. Groundwater modeling suggests that 16 extraction wells pumping between two to four gallons per minute would provide capture for the groundwater contaminant plume (Figure 4). The extracted groundwater would be treated above-ground with a combination of carbon dioxide for pH neutralization and ferric chloride as a flocculent to collect metal-bearing solids. Following treatment to meet cleanup levels, the treated groundwater would be discharged to Sullivan Creek in accordance with a National Pollutant Discharge Elimination System (NPDES) permit.

6.3 Alternative 3 – Additional Source Control

Alternative 3, which is considered an additional source control option, involves the installation of a vertical subsurface barrier located hydraulically upgradient of the Closed CKD Pile (Figure 5). The barrier would be constructed of low-permeability bentonite slurry and would intercept and direct water away from the Closed CKD Pile. Conceptual design suggests dewatering wells are needed upgradient of the slurry wall to capture and direct groundwater around the Closed CKD Pile. The slurry wall would key into the underlying low-permeability soil that ranges from approximately 60 to 120 feet deep. The slurry wall and dewatering wells would provide some source control by limiting the groundwater that contacts the CKD. This source control alternative would result in less CKD-affected groundwater than without such source control, but would not eliminate it. CKD-affected groundwater would continue to be generated from the inundated areas that are discussed in Alternative 4, as well as from groundwater that flows through potential imperfections in the slurry wall. Since CKD-affected groundwater would continue to be generated, this alternative would need to include downgradient groundwater extraction and aboveground treatment components to address the groundwater plume.

6.4 Alternative 4 – Partial Source Removal

Alternative 4 is considered a source control option by using a partial source (i.e., CKD) removal remedy. Ecology views this alternative as a permanent remedy for the Site. Ecology has identified two inundated areas where groundwater encounters the bottom of the Closed CKD Pile. The first of the areas is located at the toe of the Closed CKD Pile in the area of monitoring well MW-3 (Figure 6). Due to concerns regarding slope stability, sheet piles would have to be used to stabilize and segregate the previously identified area at the toe of the Closed CKD Pile. An estimated 5,500 cubic yards of CKD would be removed in this area to eliminate the CKD that is contact with groundwater. The second area that contacts groundwater is located near borings B-3 to B-7 (Figure 3). In order to access these materials, a portion of the engineered cover would need to be exposed and laid back, thus providing access for excavation of the CKD using conventional slope back techniques. CKD removal in this area would involve removing approximately 260,000 cubic yards of overlying CKD to access the inundated CKD (Ecology, 1997). This alternative would require the construction of a five-acre temporary storage area to stage the excavated CKD during excavation and backfilling. Engineered fill would be placed into the excavation to a predetermined height above the high groundwater elevation and overlaid with geotextile and a low-permeability soil layer. The remainder of the excavation would be backfilled with the temporarily stockpiled CKD. Excess CKD would be transported off-site for proper disposal. Following CKD replacement to grade, the cover system would be repaired by replacement and integration of cover system components.

6.5 Alternative 5 – Funnel and Gate Treatment

A funnel and gate system coupled with groundwater treatment comprises Alternative 5. The funnel component of the alternative would consist of a subsurface hydraulic barrier wall downgradient of the Closed CKD Pile that intercepts and directs groundwater toward a treatment corridor (Figure 7). A gravel drainage layer located immediately upgradient and within the interior of the barrier wall would provide a higher permeability flow path for groundwater as it enters the funnel. After groundwater is intercepted and funneled toward the gate, it would encounter an in-situ treatment corridor. The corridor treatment would consist of a series of permeable treatment walls. The walls would utilize the treatment technologies discussed in Alternative 1. The treated groundwater would eventually discharge to Sullivan Creek through a subsurface engineered effluent outfall in accordance with a NPDES permit.

6.6 Alternative 6 – Partial Additional Source Control

Alternative 6 combines two cleanup concepts (Figure 8). The first component is source control, which is provided with a gravity drain. The drain would be installed along the southern edge of the Closed CKD Pile in order to capture and redirect unaffected groundwater away from the Closed CKD Pile. This technique would allow the interception and conveyance of water that would eventually come in contact with the CKD. Conceptually, the reduction in groundwater that contacts the CKD will result in a decrease in contamination production and, therefore, the amount of groundwater that will require treatment.

The second portion of the cleanup alternative is the funnel and gate treatment system described in Section 6.5 – Alternative 5. If the gravity drain picks up contaminated groundwater, it would have the ability to discharge to the treatment system.

6.7 Cleanup Action Evaluation Criteria

The criteria used to evaluate cleanup actions are presented in WAC 173-340-360. All cleanup actions must meet the following four threshold requirements.

- Protect human health and the environment
- Comply with cleanup standards set forth in WAC 173-340-700 through 760
- Comply with applicable state and federal laws
- Provide for compliance monitoring

Other requirements for cleanup actions that meet threshold criteria include the following:

- Use permanent solutions to the maximum extent practicable
- Provide for reasonable restoration time frame
- Consider public concerns raised during the public comment period on DCAP

WAC 173-340-360(3)(b) describes the specific requirements and procedures for determining whether a cleanup action uses permanent solutions to the maximum extent practicable. A permanent solution is defined as one where cleanup levels can be met without further action being required at a site, other than the disposal of residue from the treatment of hazardous substances. To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis is conducted. This analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors, including:

- Protectiveness;
- Permanent reduction of toxicity, mobility and volume;
- Cost;
- Long-term effectiveness;
- Management of short-term risks;
- Implementability; and
- Consideration of public concerns.

The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment.

WAC 173-340-360(4) describes the specific requirements and procedures for determining whether a cleanup action provides for a reasonable restoration time frame.

Groundwater Cleanup Action Requirements

At sites with contaminated groundwater, WAC 173-340-360(2)(c) requires that the cleanup action meet certain additional requirements. For non-permanent groundwater cleanup actions, the regulation requires that the following two requirements be met:

1) Treatment or removal of the source of the release shall be conducted for liquid wastes, areas of high contamination, areas of highly mobile contaminants, or substances that can't be reliably contained; and
2) Groundwater containment (such as barriers) or control (such as pumping) shall be implemented to the maximum extent practicable.

Cleanup Action Expectations

WAC 173-340-370 sets forth the following expectations for the development of cleanup action alternatives and the selection of cleanup actions. These expectations represent the types of cleanup actions Ecology considers likely as a result of the remedy selection process; however, Ecology recognizes that there may be some sites where cleanup actions conforming to these expectations are not appropriate.

- Treatment technologies will be emphasized at sites with liquid wastes, areas with high concentrations of hazardous substances, or with highly mobile and/or highly treatable contaminants;
- To minimize the need for long-term management of contaminated materials, hazardous substances will be destroyed, detoxified, and/or removed to concentrations below cleanup levels throughout sites with small volumes of hazardous substances;
- Engineering controls, such as containment, may need to be used at sites with large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable;
- To minimize the potential for migration of hazardous substances, active measures will be taken to prevent precipitation and runoff from coming into contact with contaminated soils or waste materials;
- When hazardous substances remain on-site at concentrations which exceed cleanup levels, they will be consolidated to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substances;
- For sites adjacent to surface water, active measures will be taken to prevent/minimize releases to that water; dilution will not be the sole method for demonstrating compliance;
- Natural attenuation of hazardous substances may be appropriate at sites under certain specified conditions (see WAC 173-340-370(7)); and

- Cleanup actions will not result in a significantly greater overall threat to human health and the environment than other alternatives.

6.8 Evaluation of Proposed Remedial Alternatives

The remedial alternatives proposed in the feasibility study were evaluated according to the criteria set forth in WAC 173-340-360 and discussed in the prior section of this report. The six alternatives meet the threshold requirements to varying degrees. The alternatives will be listed with high, moderate or low ranking for protectiveness of human health and the environment.

Each alternative is considered protective of human health and the environment since each captures and treats groundwater to meet established Site cleanup levels at the applicable point of compliance. Each alternative is compliant with applicable federal and state requirements and provides for compliance monitoring. Therefore, each alternative meets the threshold criteria set forth in WAC 173-340-360(2)(a).

The second component used to evaluate alternatives is WAC 173-340-360 (2)(b) ("Other Requirements"), which includes requirements that remedies use permanent solutions to the maximum extent practicable, reflect the consideration of public concerns, and provide for a reasonable restoration time frame. The following evaluation assumes that Alternative 4 is a permanent solution for the Site. For the purpose of evaluation, Ecology considers the public concern for each alternative to be equivalent and will rely on actual public input to gauge public concern. In addition, each alternative provides for compliance monitoring.

6.8.1 Alternative 1

Alternative 1 extends the permeable treatment wall to intercept contaminated groundwater and treat it with diffused carbon dioxide. The permeable treatment wall alternative meets the MTCA cleanup action threshold criteria. This alternative has been given a moderate degree of permanence since it will require groundwater treatment well into the future. A longer restoration time frame would be realized since no source removal will be conducted. Since the technology has been installed and demonstrated at the Site, the implementability of the alternative is known and can be completed. The long-term effectiveness of this alternative is high since the same treatment technology has been demonstrated on-site for over two years. The short-term risks are that workers may be exposed to high pH water during construction. The remainder of the installation has typical construction related risks that can readily be addressed with proper safety precautions.

6.8.2 Alternative 2

Alternative 2 utilizes the current pilot treatment wall with pump and treat technology. This alternative has been given a moderate degree of permanence since it will require groundwater treatment well into the future. A longer restoration time frame would be realized since no source removal will be conducted. Pump and treat technology can be implemented at the Site from both a technical and administrative standpoint. However, pump and treat at the Site presents challenges because of the proximity to Sullivan Creek. The short-term risks associated with the alternative are that workers may be exposed to high pH water during well construction. Workers will also be exposed to treatment solids from the aboveground treatment system.

6.8.3 Alternative 3

Alternative 3 is the additional source control alternative that diverts groundwater around the Closed CKD Pile. A pump and treat system would augment the source control technology. A moderate to high degree of permanence was assigned to this alternative since a source control component is included as part of the remedy. Since source removal would not be conducted, a longer restoration time frame is envisioned. However, a shorter restoration time frame may be realized versus the groundwater treatment-only alternatives since hydraulic isolation would greatly reduce the volume of CKD affected groundwater that requires treatment. As discussed in Alternative 2, pump and treat technology can be implemented administratively and technically at the Site.

The technical implementation of source control around the Closed CKD Pile presents many challenges. The most critical aspect of these challenges is the slurry wall installation along the southern edge of the Closed CKD Pile. Given historic landslides in this area and the hill slope and pile interface, slurry wall installation would be very difficult. Due to slope stability issues, short-term risks include the potential to activate landslides as well as risks discussed regarding pump and treat systems.

6.8.4 Alternative 4

Partial source removal is considered a permanent remedy since source control is being utilized. For the purpose of the FS, Ecology requested that Alternative 4 be considered a permanent remedy so other alternatives could be compared for evaluation. In this draft cleanup action plan, this alternative is considered a permanent remedy. Groundwater treatment will be required for a period of time until the system reaches equilibrium. Ecology requested that a five-year and indefinite period be evaluated in the FS in order to assess the required groundwater treatment. As discussed below, cost and implementation considerations disfavor this alternative.

The alternative would be very difficult to implement, since Site constraints and material handling would present many challenges. Stability and safety issues are the main factors associated with handling saturated CKD. While the alternative is considered technically implementable, the difficulties associated with its implementation, including acquiring additional land for temporary CKD storage, make the alternative very difficult at this location. The short-term risks include the potential to activate landslides, the partial removal of the cover system and handling of CKD, and the aforementioned risks associated with pump and treat systems.

6.8.5 Alternative 5

Alternative 5 ranked moderate for permanence, since it will require groundwater treatment for an indefinite period. A longer restoration time frame would be realized since no source removal will be conducted. The funnel and gate system can be implemented at the Site from both a technical and administrative standpoint. Additional caution will be required during funnel wall emplacement because of the proximity of utilities. The treatment system aspect of the alternative has been demonstrated at the Site. As a result, the implementability of the alternative is known and it can be completed. The long-term effectiveness of this alternative is high. The primary short-term risk is that workers may be exposed to high pH water during construction. The remainder of the installation has typical construction related risks that can readily be addressed with proper safety precautions.

6.8.6 Alternative 6

Alternative 6 ranked moderate to high for permanence since the alternative provides a source control component in addition to the groundwater treatment component. Alternative 6 can be implemented at the Site from both a technical and administrative standpoint. The treatment system technology has been demonstrated at the Site. The long-term effectiveness of this alternative is expected to be high. The primary short-term risk is that workers may be exposed to high pH water during construction. The remainder of the installation has typical construction related risks that can readily be addressed with proper safety precautions. Alternative 6 balances the applicable remedy selection criteria in a way that meets cleanup standards and provides a significant degree of permanence by reducing the toxicity and mobility of metals in groundwater.

7.0 SELECTED CLEANUP ACTION

Ecology is selecting Alternative 6 presented in the FS, as modified below. The selected cleanup action addresses Site groundwater contamination. The cleanup action plan meets the threshold requirements and was given preference for treating groundwater and providing source control.

Groundwater contamination from the Closed CKD Pile continues to be present from the pile flowing beneath Highway 31 to Sullivan Creek. The highest beneficial use of Site groundwater is as a drinking water source. The groundwater contaminant plume extends from the Closed CKD Pile and flows northeast for approximately 360 feet and discharges to Sullivan Creek. The metals contaminant plume lies within the boundary of the pH plume. In addition to providing treatment of contaminated groundwater, the selected groundwater remedy will provide a source control component by capturing groundwater along the southern edge of the Closed CKD Pile and routing the water to the area east of State Route 31. Depending on the captured groundwater quality, the water may either be directed toward the treatment system or allowed to discharge below ground.

Additional monitoring wells, the number of which will be determined during the Engineering Design Report, will be completed to assess the efficacy of the source control gravity drain. The newly installed wells will be monitored as part of the performance monitoring plan. The Draft Engineering Design Report will include a plan to evaluate the source control provided by the gravity drain. To monitor the treatment system, groundwater samples will be collected from new performance monitoring wells installed with the treatment system. In addition, groundwater samples will be collected from current monitoring wells MW-12, PM-1, PM-5, PM-15, and PM-19, as well as new performance monitoring wells installed with the treatment system. The wells will be sampled on a quarterly basis until such time a less frequent schedule is warranted. A more frequent sampling schedule is anticipated prior to and immediately following system start up.

The samples should be analyzed for pH and arsenic, chromium, lead, and manganese. Additional analysis to meet the NPDES discharge permit requirements will also be necessary.

7.1 Point of Compliance

A groundwater conditional point of compliance may be approved where it can be demonstrated that it is not practicable to meet cleanup levels throughout a site. In addition, if hazardous substances remain on-site as part of the cleanup action, a groundwater conditional point of compliance, which shall be as close as practicable to the source of hazardous substances not to exceed the property boundary, may be approved. Since Lehigh owns the property on both sides of State Route 31 up to Sullivan Creek and since it is not practicable to meet cleanup levels in groundwater throughout the Site because the Closed CKD Pile will remain in place, a conditional compliance is appropriate. If a groundwater conditional point of compliance is used, the proponent shall demonstrate that all practicable methods of treatment are to be utilized in the cleanup action (WAC 173-340-720(8)(c)). The selected alternative meets the criteria since containment and treatment will be utilized as part of the cleanup action. A groundwater conditional point of compliance for all groundwater outside of the subsurface hydraulic barrier will be used and established at the groundwater/surface water interface. Monitoring will be used to establish compliance with this conditional point of compliance granted under WAC 173-340-720(8)(d)(i).

Groundwater that passes through the treatment system will be discharged to surface water through a subsurface engineered effluent outfall. This treated effluent will be subject to an NPDES permit and a point of compliance for surface water cleanup levels pursuant to WAC 173-340-730(6)(a).

7.2 Institutional Controls

Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the cleanup action or result in the exposure to hazardous substances at a site. Institutional controls are required where cleanup actions result in residual concentrations of hazardous substances exceeding cleanup levels established for a site. These controls may not be used as a substitute for a cleanup that is technically possible. Since the cover system on the Closed CKD Pile and portions of the groundwater remedy utilize a containment technology, institutional controls will be required. The institutional controls for the cover system on the Closed CKD Pile have already been established through an Ecology approved Post-Closure Care and Maintenance Plan. These institutional controls will be continued as part of the selected alternative.

Groundwater contamination occurs beneath the Closed CKD Pile and flows beneath State Route 31 to property east of the roadway. Lehigh has purchased the property east of the highway and therefore controls land ownership overlying the groundwater plume to Sullivan Creek. The institutional control requirements are set forth in WAC 173-340-440. The following institutional controls that prohibit and/or limit groundwater use within the groundwater contamination plume will be required, as incorporated into a restrictive covenant to be filed with the office of the Pend Oreille County Auditor:

1) No groundwater may be taken from the parcel, except for purposes related to the Remedial Action, such as groundwater monitoring.

2) Lehigh shall maintain and operate the groundwater remediation system installed at the Site until such time it is agreed by Ecology and Lehigh that system operation is no longer required. This will occur when three years of quarterly monitoring data show that cleanup levels have been met in groundwater at one or more locations agreed upon by Ecology and Lehigh before it enters the treatment zone.

3) Lehigh shall maintain one or more signs warning that groundwater beneath this parcel contains elevated levels of metals and pH. A suitable barrier that restricts unauthorized access to the groundwater remediation system shall be maintained.

4) Lehigh shall provide a financial assurance mechanism to provide for the continued operation and maintenance of the cleanup action, which includes monitoring and maintaining institutional controls and operation and maintenance of the Closed CKD Pile.

7.3 Periodic Review

WAC 173-340-420 states that at sites where a cleanup action requires an institutional control, a periodic review shall be completed no less frequently than every five years after the initiation of a cleanup action. Since the waste materials remain on-site and institutional controls will be required, five-year reviews shall take place at this Site. Monitoring data shall be reviewed to continue to assess the effectiveness of the groundwater contamination treatment system. If data do not indicate that the treatment system has the capacity to treat contaminant concentrations to meet cleanup levels and meet the requirements of the NPDES permit for discharge to Sullivan Creek, then further remedial action may be considered.

8.0 EVALUATION OF THE CLEANUP ACTION USING MTCA CRITERIA

The selected remedy is evaluated using the MTCA criteria set forth in WAC 173-340-360, as follows:

8.1 Protection of Human Health and the Environment

Groundwater is the contaminated medium and focus of treatment at the Site. The exposure routes identified at the Site are via direct contact and ingestion of groundwater. The in-situ treatment of contaminated groundwater will reduce the risk from direct contact downgradient of the treatment wall and provide for protection of surface water. Institutional controls restricting groundwater withdrawal and use will limit exposure via ingestion and dermal contact.

8.2 Compliance with Cleanup Standards

Contaminated groundwater will be treated by in-situ technology involving the interception and direction of contaminated groundwater to a treatment corridor in the subsurface. The groundwater will be treated to meet cleanup levels at a point of compliance for surface water cleanup levels pursuant to WAC 173-340-730(6)(a). Groundwater outside of the subsurface hydraulic barrier will meet groundwater cleanup levels at a conditional point of compliance located at the groundwater/surface water interface. Institutional controls will be part of this cleanup action since the Closed CKD Pile will remain in-place with the cover system and contaminated groundwater from the Closed CKD Pile will flow beneath State Route 31 to the treatment system.

8.3 Compliance with Applicable State and Federal Laws

The cleanup action for this Site complies with applicable state and federal laws. The applicable state and federal laws for the implementation of the cleanup action are identified in Table 4. Local laws, which can be more stringent, will govern actions when they are applicable.

8.4 Compliance Monitoring

Compliance monitoring is divided into three categories, which are protection, performance, and confirmational (WAC 173-340-410). Protection monitoring is designed to protect human health and the environment during construction and the operation and maintenance tasks for the cleanup action. Performance monitoring confirms that the cleanup action has attained cleanup and/or performance standards.

Confirmational monitoring confirms the long-term effectiveness of the cleanup action once cleanup standards have been achieved or other performance standards have been attained. Compliance monitoring will be conducted in accordance with a Compliance Monitoring Plan, which is to be developed. The Compliance Monitoring Plan will be developed under the terms of Exhibit C (Scope of Work and Schedule) to a consent decree. In addition, monitoring of the Closed CKD Pile engineered cover system is described in the Post-Closure Care and Maintenance Plan previously developed for the Closed CKD Pile (to be attached as Exhibit G to a consent decree). The monitoring requirements in Section 5 of Exhibit G will be superseded by the requirements of the Compliance Monitoring Plan developed pursuant to Exhibit C, Scope of Work and Schedule

8.5 Use Permanent Solutions to the Maximum Extent Practicable

A permanent solution is one in which cleanup standards can be met without further action being required. Ecology believes that Alternative 4 (partial source removal) may provide a permanent solution for the Site. There are serious obstacles to implementation of Alternative 4, however, and even after implementation, groundwater treatment would still be required for some time. Alternative 6, the selected remedy, provides a moderate to high degree of permanence and can be readily implemented.

8.5.1 Protection of Human Health and the Environment

The remedy selected for groundwater is considered protective of human health and the environment. The groundwater remedy is considered protective since it will contain and treat contaminated groundwater. Cleanup levels will be met at the applicable points of compliance for groundwater and surface water.

The source control aspect of the alternative will reduce the amount of groundwater requiring treatment. Institutional controls will prohibit the withdrawal and use of the contaminated groundwater at the Site prior to its treatment. Achieving groundwater and surface water cleanup standards will be assessed as part of the review process up to the five-year review required under WAC 173-340-420. If groundwater and surface water cleanup levels have not been met at their respective points of compliance, additional cleanup action may be required. Performance monitoring will be completed according to the schedules established pursuant to Section 8.4 above.

8.5.2 Long-Term Effectiveness

The long-term effectiveness of the groundwater remedy will be assessed as source control reduces the amount of groundwater requiring treatment. The in-situ groundwater treatment system is expected to lower pH levels to within the cleanup level range of 6.5 to 8.5 s.u., which will result in metals removal to below the established cleanup levels.

8.5.3 Short-Term Effectiveness

Risks associated with the cleanup action in the short term are the potential exposure of workers to the contaminated groundwater during excavation and installation of the groundwater treatment system. Institutional controls to prevent contact with contaminated groundwater will minimize the short-term risks while the groundwater remedy is implemented. Worker health and safety will be addressed as part of the Draft

Engineering Design to comply with the appropriate regulations and to satisfy the protection monitoring requirements.

8.5.4 Permanent Reduction of Toxicity, Mobility, and Volume

Groundwater source control with the gravity drain will reduce the toxicity, mobility, and volume of contaminants in groundwater. Groundwater treatment will reduce the contaminants in groundwater to meet cleanup levels at the point of compliance for surface water cleanup levels pursuant to WAC 173-340-730(6)(a).

8.5.5 Implementability

The selected cleanup action can be readily implemented since it involves the use of conventional remediation technologies and innovative technologies that have been demonstrated at the Site. It is anticipated that the conceptual design of Alternative 6 may be modified for final implementation. The remedial design will more fully evaluate and describe how Alternative 6 will be constructed and operated.

8.5.6 Cost

The cost provided in the FS for the selected alternative ranges between 2.4 to 3 million dollars for capital costs. The projected annual operation and maintenance (O&M) costs for the groundwater treatment and monitoring is $150,000**.** Costs developed using a seven-percent interest rate and an O&M life of 30 years yielded a cost estimate of 4.5 to 5.1 million dollars for the alternative.

8.6 Provide Reasonable Restoration Time Frame

The proposed cleanup action will provide source control measures by intercepting groundwater and directing it away from the Closed CKD Pile. As a result, it will reduce the amount of contamination generated. While a reduction in CKD-affected groundwater will be realized by the gravity drain, groundwater treatment will still be necessary for an indefinite period. However, restoration to meet cleanup levels at the surface water point of compliance should occur once the cleanup action is fully implemented. Full cleanup action implementation will include a two-year Optimization Phase. Additionally, the discharge is subject to the requirements of a NPDES permit and a mixing zone under WAC 173-201A may be considered. Details of the monitoring program, including parameters and frequency, will be specified in the Compliance Monitoring Plan.

Monitoring and periodic review will provide an assessment tool for the cleanup action. Small areas within the footprint of the current contaminated groundwater plume will be outside of the subsurface hydraulic barrier after it is constructed. These remnant plume areas will not be captured by the barrier after its placement and will continue to discharge to Sullivan Creek until they have been exhausted. A conditional point of compliance for these remnant plume areas and all groundwater outside of the subsurface hydraulic barrier will be established at the groundwater/surface water interface, with compliance monitoring to be established within groundwater as close to the groundwater/surface water interface as practicable. Monitoring wells will serve as the conditional points of compliance and the number and location of the wells will be discussed in the Engineering Design Report   As specified in WAC 173-340-720(8)(d)(i)(C), no mixing zone is available for this groundwater discharge. Ecology recognizes that the discharge from these remnant plume areas represents only a small fraction of the current contaminant loading from this Site. Therefore, a restoration time frame for this discharge will be evaluated during the five-year review. A declining trend in concentration must be observed at the points of compliance for the remnant plume during the review. Following the first five-year review, Ecology and Lehigh will determine whether evaluation tools such as modeling and statistical analysis will be necessary to evaluate the groundwater discharge. In the event a groundwater contaminant reduction consistent with a reasonable restoration time frame is neither observed nor predicted with available evaluation tools, Ecology will, consistent with WAC 173-340-420, consider the necessity of additional remedial action to address contaminated groundwater outside of the subsurface hydraulic barrier.

8.7 Public Participation and Community Acceptance

A public comment period will be held to allow the public and parties affected by the cleanup action an opportunity to provide comment on this document. Public comments and concerns will be addressed in a responsiveness summary and incorporated as appropriate in the final cleanup action plan.